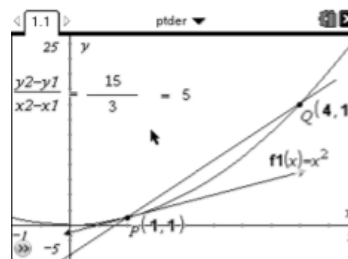


## 2.4b Instantaneous Rate of Change

Estimate the instantaneous velocity at  $t=1$



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Find the exact instantaneous velocity at  $t=1$

$$\lim_{h \rightarrow 0} \frac{f(1+h) - f(1)}{h}$$

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Example 3 Find the equation of the tangent to the parabola  $y=x^2$  at  $x=2$

pt-slope eqn:  $y = m(x - x_1) + y_1$

$$x_1 = 2 \quad x_2 = 2+h$$

$$y_1 = 4 \quad y_2 = (2+h)^2$$

$$\lim_{h \rightarrow 0} \frac{(2+h)^2 - 4}{h} = \lim_{h \rightarrow 0} \frac{\cancel{4} + 4h + \cancel{h^2} - \cancel{4}}{h}$$

$$\lim_{h \rightarrow 0} \frac{\cancel{h}(4+h)}{\cancel{h}} = 4$$

$m_{\text{tan}} = 4$

$$y = 4(x-2) + 4$$

$$= 4x - 4$$

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Example 5 Find an equation for the normal to the curve  $y=4-x^2$  at  $x=1$

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$$x_1 = 1 \quad x_2 = 1+h$$

$$y_1 = 3 \quad y_2 = 4 - (1+h)^2$$

$$\lim_{h \rightarrow 0} \frac{4 - (1+h)^2 - 3}{h} = \lim_{h \rightarrow 0} \frac{4 - (1 + 2h + h^2) - 3}{h}$$

$$= \lim_{h \rightarrow 0} \frac{\cancel{4} - \cancel{1} - 2h - \cancel{h^2} - \cancel{3}}{h}$$

$$y = \frac{1}{2}(x-1) + 3$$

$$\lim_{h \rightarrow 0} \frac{\cancel{h}(-2-h)}{\cancel{h}}$$

$$m_{\text{tan}} = -2$$

$$m_{\perp} = \frac{1}{2}$$

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Example 6 Find the <sup>exact</sup> speed of a falling rock at  $t=1$  if the distance it falls is  $y=16t^2$  ft <sup>Sec</sup>

$$x_1 = 1 \quad y_1 = 16$$

$$x_2 = 1+h \quad y_2 = 16(1+h)^2$$

$$\begin{aligned} \lim_{h \rightarrow 0} \frac{16(1+h)^2 - 16}{h} &= \lim_{h \rightarrow 0} \frac{16(1+2h+h^2) - 16}{h} \\ &= \lim_{h \rightarrow 0} \frac{\cancel{16} + 32h + 16h^2 - \cancel{16}}{h} \\ &= \lim_{h \rightarrow 0} \frac{\cancel{h}(32 + 16h)}{\cancel{h}} \\ &= 32 \frac{\text{ft}}{\text{sec}} \end{aligned}$$

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